Kraftelektronik AB

Installation manual for charging rectifier type PCR1

SAFETY INSTRUCTION

This manual must be read **before** installation, usage or work in the product.

This product contains dangerous voltage that when touched can cause electrical shock, burn or death.

The product must be installed by qualified personnel and according to the installation instructions. Service may only be performed by authorized service personnel. The rectifier cover may only be removed by qualified personnel and with the rectifier in dead condition since at least 5 minutes. Other protective covers may only be removed by authorized service personnel.
The power must always be disconnected in a safe way before any service/maintenance work begins.

WARNING! Multiple power sources. Dangerous voltage is possible even with mains power shut off. The panel mains switch does not give a dead condition.

Manual 9-1580-B
P/n 0001050

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CONTENTS

We retain the rights to make changes to these specifications without further notice.

1 GENERAL

Charging rectifier type PCR is a primary switched mode charging rectifier family with integrated monitoring unit.

This description only treats charging rectifiers in 1-phase variant, i.e. charging rectifiers with type designation PCR1. The description mainly applies to designers and personnel that are responsible for installation, service and maintenance.

For information regarding usage of the charging rectifier, see the *Users manual*.

For systems with charging rectifiers in parallel operation and double DC-systems, additional information can be found in the *Supplementary installation manual*.

The term "charging rectifier" will henceforth be substituted by the term "rectifier".

By safety reasons, concerned personnel are divided into different classes with the following demands on specific qualifications:

Authorized service personnel:

- Has electrical education and adequate experience to avoid the dangers that electricity can cause.
- Has certificated qualification according to competent authorities for the work in question.
- Has knowledge of languages that implies that the content in this description can not be misunderstood.
- Has went through a product specific education programme for authorized service personnel that is approved by Kraftelektronik AB.

Qualified personnel:

- Has electrical education and adequate experience to avoid the dangers that electricity can cause.
- Has certificated qualification according to competent authorities for the work in question.
- Has knowledge of languages that implies that the content in this description can not be misunderstood.

2 TECHNICAL DATA

2.1 ELECTRICAL DATA

2.1.1 Common electrical input data

Rated voltage	220V/230V/240V AC 1-phase
Input voltage, range	195 - 264V_{AC}
Frequency	45-65Hz
Power factor	0.99 (at nominal load)
Terminal block	0-4mm^2

2.1.2 Common electrical output data

Output voltage	See "Model depending electrical data"
Voltage regulation (static)	<±0.5% of nominal output voltage (U_{NOM})
Voltage regulation (dynamic①)	<±1% within 3 seconds
Setting range, float charging	0 - maximum output voltage (U_{MAX})
Setting range, equalizing charging	0 - maximum output voltage (U_{MAX})
Current regulation	<±1% of rated current (I_{RATED})
Setting range, current limit	0 - 100% of rated current (I_{RATED})
Ripple voltage	<0.05%$_{RMS}$
Ripple current	<1% of rated current (I_{RATED})
Efficiency, typical	90%
Terminal block	10mm^2 (for rated current <15A) 10mm^2 (for rated current ≥15A)

① during change of load 0-100% and 100-10% respectively.

2.1.3 Common electrical data for monitoring unit

Voltage measuring, inaccuracy	<±0.2% of nominal output voltage (U_{NOM})
Voltage measuring, range	See "Model depending electrical data"
Current measuring, inaccuracy	<±1% of rated current (I_{RATED})
Current measuring, range	0 - 100.9% of rated current (I_{RATED})
Battery temperature measuring, inaccuracy	<±1.5°C
Battery temperature measuring, range	0 - 50°C
Earth fault resistance measuring, inaccuracy	<±15%, 50kΩ - 1MΩ
Earth fault resistance measuring, range	0 - 5MΩ
Earth fault terminal, internal resistance R_{IN}	>200KΩ
Pluggable terminal block for monitoring	0-2.5mm^2
Alarm relay, contact data, maximum	AC: 250V 8A DC:125V 0.15A (30V 5A) at L/R=7ms

3.1.4 Model depending electrical data

Model of PCR1	Output data					Connection data			Rectifier unit	Monitoring unit
	U_{NOM}	U_{MAX}	I_{RATED}	Recommended number of cells		Mains power	Mains current	Mains fuse, maximum	Maximum loss of power	Voltage measuring range
	(V)	(V)	(A)	Lead	Alkal.	(VA)	(A_{RMS})	(A_{SLOW})	(W)	(V)
PCR1 24/10	24	32.5	10	11-13	17-21	330	1.7	6	28	35.84
PCR1 24/20	24	32.5	20	11-13	17-21	660	3.4	6	56.8	35.84
PCR1 24/35	24	32.5	35	11-13	17-21	1160	6.0	10	100	35.84
PCR1 48/10	48	65	10	22-26	35-40	660	3.4	6	56.8	71.68
PCR1 48/20	48	65	20	22-26	35-40	1330	6.8	10	115	71.68
PCR1 48/35	48	65	35	22-26	35-40	2320	11.9	16	200	71.68
PCR1 110/5	110	150	5	52-54	78-85	690	3.5	6	66	163.8
PCR1 110/10	110	150	10	52-54	78-85	1380	7.1	10	132	163.8
PCR1 110/15	110	150	15	52-54	78-85	2080	10.6	16	198	163.8
PCR1 110/20	110	150	20	52-54	78-85	2760	14.1	16	238	163.8
PCR1 125/2	125	150	5	55-60	86-92	770	3.1	6	66	163.8
PCR1 125/10	125	150	10	55-60	86-92	1530	7.9	10	132	163.8
PCR1 125/15	125	150	15	55-60	86-92	2300	11.8	16	198	163.8
PCR1 125/20	125	150	20	55-60	86-92	3070	15.7	16	238	163.8
PCR1 220/2.5	220	280	2.5	102-112	156-184	720	3.7	6	62	327.7
PCR1 220/5	220	280	5	102-112	156-184	1430	7.3	10	124	327.7
PCR1 220/10	220	280	10	102-112	156-184	2860	14.7	16	238	327.7

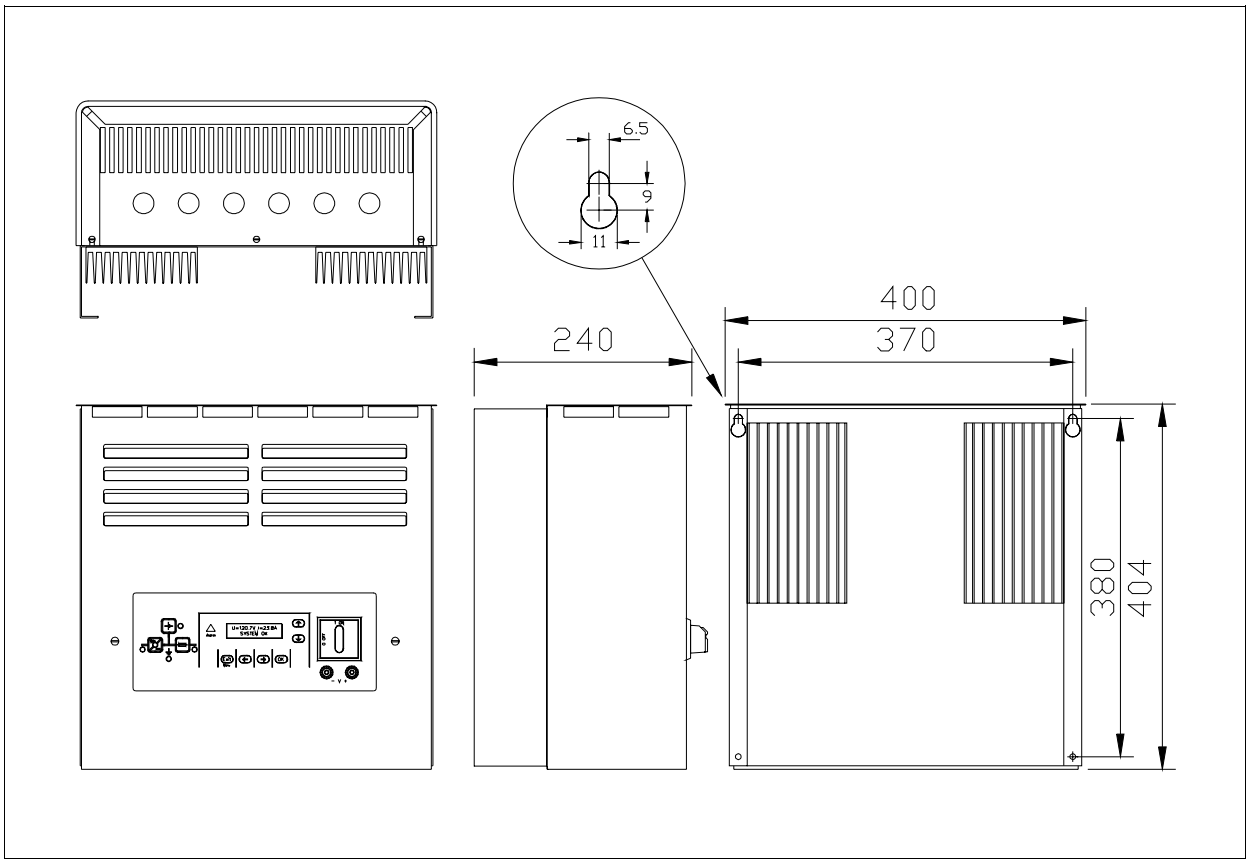
2.2 ENVIRONMENTAL DATA

Class of enclosure . . . . . IP20 according to SS-EN 60529
Cooling . . . . . Natural convection
Ambient temperature (specified data is valid) . . . . 0 to +40°C
Ambient temperature (specified data is not valid) . +40 to +50°C at reduced power[1]
Storage temperature . . . . . -40 to +70°C
Humidity . . . . . <90%RH
Altitude above see level . . . . . <1000m
Noise level . . . . . <40dBA

[1] Above +40°C, the rated output current is decreased 3.5% for every additional 1°C. This must be manually adjusted, see *Users Manual*, section *Operation, Settings, Adjust current limit level.*

2.3 MECHANICAL DATA

Weight	20 kg, valid for PCR1 model 48/35,110/15, 110/20, 125/15, 125/20, 220/10 14 kg, valid for PCR1 remaining models
Arrangement	Wall mounting
Dimensions	See dimensional drawing below
Colour	RAL 7035



Dimensional drawing, PCR1

2.4 CONFORMITY WITH STANDARDS

SS-EN 50081-1[2]	EMC. Generic emission standard, light industry.
SS-EN 50081-2[3]	EMC. Generic emission standard, industrial environment.
SS-EN 50082-2	EMC. Generic immunity standard, industrial environment.
EN 61000-3-2	EMC. Harmonics.
SS-EN 50178	LVD. Electronic equipment for use in power installations.
SS-EN 60529	Class of enclosure, IP20.

[2] Applicable if shielded cables are used according to the installation instructions.

[3] Applicable if shielded cables are not used.

3 INSTALLATION INSTRUCTIONS

3.1 SAFETY INSTRUCTIONS

WARNING! This product contains dangerous voltage that when touched can cause electrical shock, burn or death. Protective earth must **always** be properly connected. No alive parts is permitted during installation. The product must be installed by qualified personnel (see chapter 1, *General*). The protective coverings are designed for installation in IT-system (according to ELSÄK-FS 1994.7, which is based on IEC 364-4-41). For IT systems where the DC voltage level can exceed 120V (rectifier for 110V nominal voltage and higher) the following applies:

- The DC part may not be directly connected to earth.
- The DC part must be provided with earth fault detection system.

If the DC part still should be directly connected to earth., the rectifier must be provided with additional protective coverings. Please contact Kraftelektronik AB in Växjö, Sweden, for more information.

WARNING! Check both before and after setting-up that the product does not have any mechanical damages. Cables for input and output power must be correctly dimensioned to avoid fire hazard.

3.2 MOUNTING

The rectifier is intended for wall mounting indoors in a dry and clean room. It should be mounted in such a way that free air flow for the cooling flanges on the back of the rectifier is always provided.

Unscrew the two quick locking screws on the front and the two outer screws on the lower edge of the rectifier, then lift off the cabinet. Fasten the two upper mounting screws on the wall. Then, fit in the "keyhole" tappings on the rectifier so the rectifier is hanging on the screws. Finally, screw the two lower mounting holes of the apparatus on the wall.

WARNING! Due to a fall, the device can cause physical injury and damage on property. If needed, always use safe lifting equipment. Carefully ensure that mounting bolts and their attachment into the wall, with safe margin and in a safe way, are able to carry the weight of the rectifier.

3.3 ELECTRICAL INSTALLATION

3.3.1 General

Only permanent mains feeding connection is permitted. Protective earth must be connected before any other installation. All installations are made in the connection compartment in the lower part of the rectifier (see the component location drawing below).

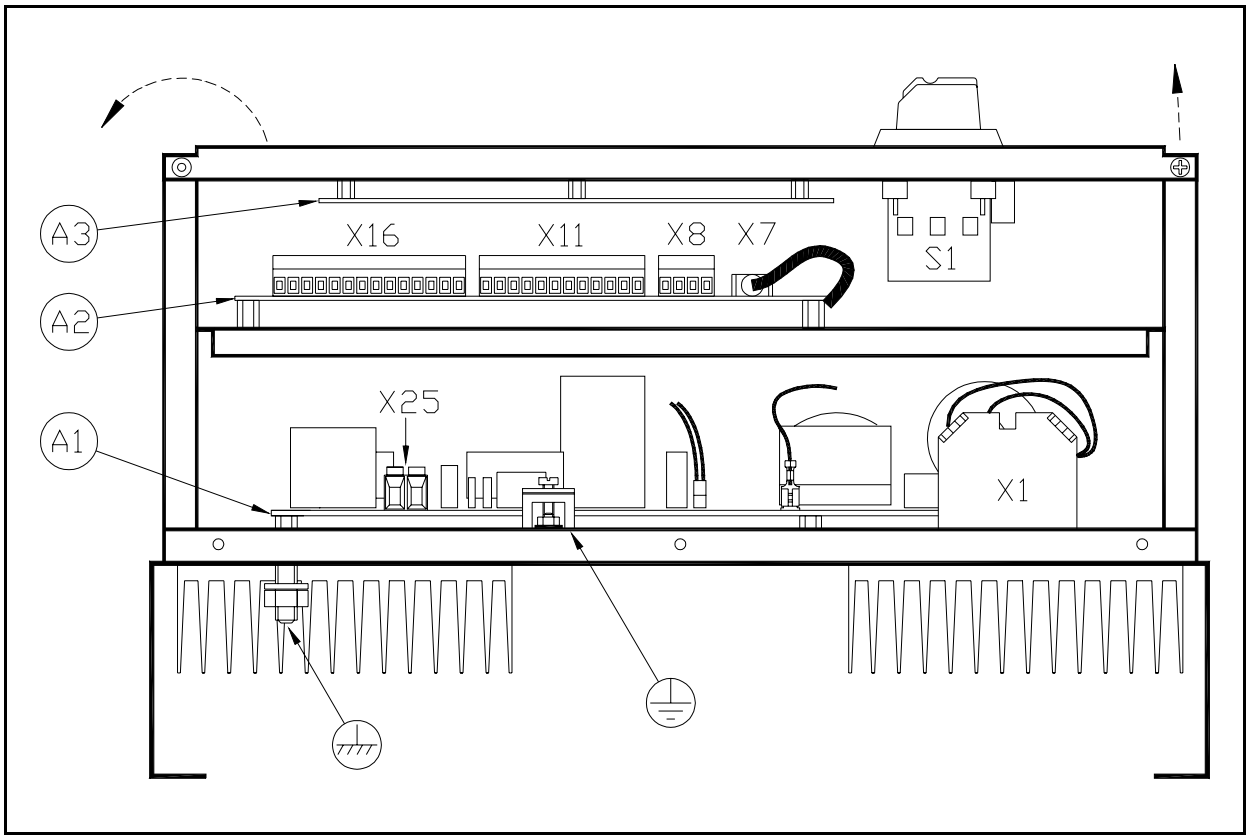
Remove the cabinet as described above.

In order to get easy access to the connection terminals, the upper panel may be turned up. Then unscrew the two screws on the right side of the panel. The panel may then be turned almost 180°. When the panel is turned back, carefully see that no cables get jammed.

For some lower power models, it is possible to use the space beneath the rectifier for cabling. In that case it is very important that the cables passes **between** the heat sinks instead of directly beneath in order to maintain the cooling air flow!

For conformity with SS-EN 50081-1 (emission, light industry) shielded cables should be used for all external connections (, otherwise SS-EN 50081-2 (industrial environment) is valid.

All connections referred to in this section concerns the terminals on the control board (A2) if nothing else is stated.



Component location, connection compartment PCR1

3.3.2 Connection of mains power

The required primary fuse rating is stated in the table found in section *Technical data*, or in appendix *Additions and changes* if the rectifier has non-standard primary data.

Connect single phase mains voltage to the terminal block X25 placed on the power board (A1).

3.3.3 Connection of battery/load

Verify that the rated voltage specified on the rectifier marking sign corresponds to the nominal voltage of the battery.

Connect the DC system to the output terminals X1 marked L+ and L- respectively. Their location is to the right on the lower part of the apparatus. Use cables that can handle the rated current of the rectifier.

WARNING! The rectifier has no internal output fuses. See that fuse protection are arranged externally.

3.3.4 Connection of measuring inputs

3.3.4.1 Connection of monitored battery voltage

All the voltages that are monitored should be measured as close to the battery and distribution unit as possible in order to avoid measuring errors due to voltage drop in cables.

Ubattery- is the minus pole common to all the voltage measurings. Connect from the minus pole of the battery to terminal X8:2.

Ubattery+ measures the total voltage of the battery. Connect from the plus pole of the battery to terminal X8:4.

Ubattery½ measures the midpoint voltage of the battery. Connect from the mid point of the battery to terminal X8:3. Use the short-circuit protected cable that is normally enclosed.
By measuring the voltage level of the mid point of the battery and thereby compare the two halves, you can in a simple but effective way catch a number of important fault conditions as for example unequal charging distribution, short-circuit in battery cells, etc.
If the midpoint voltage should be used, the midpoint voltage measuring must be activated and set with the proper parameters, see *Users Manual*, section *Operation, Selection of functions, Midvoltage.* The parameter that is set states the percentage of the total battery voltage that is expected in the mid point. It will not always be exactly 50% because it is not always possible to make a connection in the theoretical mid point. Therefore, always check that the actual measuring point corresponds to the setting.

3.3.4.2 Connection of measuring earth

Earth fault measuring are done by continuously measuring the voltage in a constructed midpoint to which the monitored earth point is connected.

If earth fault measuring is used, connect terminal X8:1 to the earth distribution bar that is found in the connection compartment.

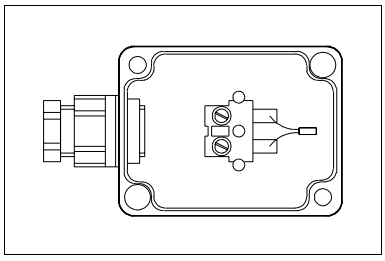
Note that the measuring point must not be located outside the connection compartment by EMC reasons. In those cases you need a disconnectable measuring earth, e.g. in double DC systems, you can use the internal facility for disconnection of the measuring earth. The disconnection control is handled via the digital input for parallel operation. Additional information can be found in the *Supplementary installation manual*.

Earth fault measuring can be disabled, see *Users Manual*, section *Operation, Selection of functions, Earth fault measuring*. A galvanic separation of the measuring input terminal will then be done internally without the need of any external disconnection.

3.3.4.3 Connection of temperature sensor

Measuring of the battery temperature is needed if you intend to use temperature regulated float charging voltage. At the same time you get a monitoring of extreme temperatures with matching alarms.

The external temperature sensor is a standard Pt-1000 resistive sensor built into a hermetic sealed enclosure, commercially named "outdoor sensor". Since the sensor is of the type Pt-1000, a two pole measuring will do, in contrast to the more commonly used Pt-100 that usually needs a four-pole measuring to prevent the measuring wire resistance to have an effect on the measuring result.



Temperature sensor (shown without covering)

Place the sensor on a spot that will best represent the battery temperature, normally the most central located point on the top of the battery.

Connect the temperature sensor to terminal X11:11-12.

The temperature sensor is an option and is therefore installed only whenever applicable. If a temperature sensor should be used, the temperature measuring function must be enabled, see *Users Manual*, section *Operation, Selection of functions, Temperature measuring*.

3.3.5 Connection of digital inputs

3.3.5.1 General

The digital inputs are power supplied from the internal auxiliary power of the rectifier (approximately 12VDC). Therefore, they may only be connected to zero-potential contacts.

Closed input means normal state. Open input is activated state. It means that the two terminals of each input that is not used must be interconnected!

3.3.5.2 Connection of equalization charging blocking input

In open state, the equalization charging is prohibited. Is mainly used to, via a vent flow monitor, prevent equalization charging in case of a malfunctioning battery compartment fan ventilator.

Is connected to terminal X11:3-4.

3.3.5.3 Connection of parallel operation control input

Open input means that the DC system in which the rectifier is part of, operates in connection with another DC system. It means, among other things, that the earth fault measuring automatically is measured in only one rectifier in the complete double DC system. For additional information, see the *Supplementary installation manual*.

Is connected to terminal X11:5-6.

3.3.5.4 Connection of fuse monitoring input

Monitors an optional number of fuses through auxiliary fuse contacts connected i series. Open loop means tripped fuse.

Is connected to terminal X11:7-8.

3.3.5.5 Connection of rectifier blocking input

An open input immediately results in a shutting off of the rectifier. Is functionally placed side by side with the mains switch in off position.

Is connected to terminal X11:9-10.

3.3.6 Connection of digital outputs

3.3.6.1 General

The digital outputs consists of zero-voltage relay contacts. Electrical ratings for the contacts are found-in section *Electrical data* earlier in this chapter.

The terminals for the outputs are marked C, NC and NO respectively. The implication of this is:

- C - Point for Common connection.
- NC - Connection point for Normally Closed contact.
- NO - Connection point for Normally Open contact.

The meaning of the word normally is in this case "no alarm" and "not activated" respectively. We recommend the use of the condition NC. It increases the reliability since also a possible bad contact function will give an alarm. In order to further raising the reliability, all alarm relays are close circuit working, i.e. an energized relay indicates normal state while a fallen relay gives alarm. It means that also a faulty relay or lack of auxiliary power will cause an alarm indication.

3.3.6.2 Connection of alarm output relays

Connections to the alarm output relays are done according to the following:

- Alarm relay A . . . . . C . . . . . Terminal X16:1
  NC . . . . . Terminal X16:2
  NO . . . . . Terminal X16:3
- Alarm relay B . . . . . C . . . . . Terminal X16:4
  NC . . . . . Terminal X16:5
  NO . . . . . Terminal X16:6
- Alarm relay C . . . . . C . . . . . Terminal X16:7
  NC . . . . . Terminal X16:8
  NO . . . . . Terminal X16:9
- Alarm relay D . . . . . C . . . . . Terminal X16:10
  NC . . . . . Terminal X16:11
  NO . . . . . Terminal X16:12

The relations between the alarm relays and existing alarm alternatives can be set with in principle unlimited degree of freedom, see *Users Manual*, section *Operation, Alarm settings*. See also in the same manual, section *Operation, Test* for a description of how the alarm circuits, in a simple way, can be tested.

For usage of alarm relay D in double DC systems, see the *Supplementary installation manual*.

3.3.6.3 Connection of battery compartment fan ventilator

The output for control of a battery compartment fan ventilator is automatically activated by an equalization charging. To ensure that all hydrogen gas is vented out, the output continues to be activated for another 10 minutes after finished equalization charging.

Is connected to terminal X16:13-14. The relay contact is normally open (NO) and is closed for the fan to start.

3.3.7 Connection of serial data communication

3.3.7.1 General

The rectifier is supplied with two different systems for serial communication. KraftNet is mainly used for communication with other rectifiers but also for communication with superior systems of the type KraftMaster. The I^2C bus is mainly an internal serial channel for communication between the control-board and the display unit. In some cases, the I^2C bus could also be connected to external units which then is located either inside the connection compartment or very close to the rectifier. The I^2C connection between control board and display unit also gives an opportunity to an alternate location of the display unit, e.g. on the front door of a cabinet in case the rectifier is mounted inside a cabinet.

3.3.7.2 Connection of KraftNet

KraftNet is connected to X11:1-2 using shielded cable. The polarization does not matter. The shield should be grounded in both ends.

3.3.7.3 Connection of I^2C-bus

The I^2C bus is always connected using a cable assembly of so called USB-type (commonly used between computers and their peripheral units). In a standard PCR1 rectifier, the cable assembly is already connected with one end visible in the terminal X7 while the other end disappears into the rectifier where it is connected to the display unit. I those cases where the display unit should be-mounted in some other way or other peripheral units should be connected, then see the separate installation instructions that should be supplied for this matter.

4 STARTING UP

4.1 SAFETY INSTRUCTIONS

WARNING! This product contains dangerous voltage that when touched can cause electrical shock, burn or death. All protective coverings and plates must be mounted during operation.

4.2 SETTING ALIVE

First, connect battery power, for instance by using a fuse to close the battery circuit. The monitoring unit will now start. Note that a starting current surge occurs when the filter capacitors in the rectifier are charged. It may cause sparking at the engaging point.

The set the voltage measuring inputs alive.

At last, switch on the mains power.

4.3 START

Turn the panel mains switch in position 1 (On).

Battery charging now commences. If the battery was deeply discharged, charging will commence at the rated current, and this will continue until the float charging level is reached. Some battery types needs an initial equalizing charging. Always follow the instructions stated by the battery manufacturer.

4.4 CHECKING OF THE CHARGING VOLTAGE

Check that the rectifier voltage settings corresponds to the specifications stated by the battery manufacturer, see *Users manual*, section *Operation, Settings*.

When the battery reached such a charging level so that the alarm "High current" no longer is active, you should check that the actual output voltage really corresponds to the preset float charging voltage. See section *Maintenance, Annual inspection, Checking of charging voltage*.

4.5 CHECKING OF THE SETTINGS

Check that displayed measures corresponds to real values. Check alarm settings and other parameters so they corresponds to intended function, see *Users manual*, section *Operation*.

For maximum safety, see that the OVP function (OverVoltage Protection) is activated (see *Users manual*, section *Operation, Advanced, Selection of functions, Overvoltage protection*). The protection is normally activated at the time of delivery.

4.6 CHECKING OF THE ALARM OUTPUTS

The alarm relays A-D can be manually manoeuvred for checking of the external circuits that are connected to the alarm output relays, see *Users manual*, section *Operation, Test*.

5 MAINTENANCE

5.1 SAFETY INSTRUCTION

WARNING! This product contains dangerous voltage that when touched can cause electrical shock, burn or death.
Never remove the covering with the apparatus is live condition. Also ensure that it has been in a dead condition for at least 5 minutes, giving the internal circuits time to discharge.

5.2 ANNUAL INSPECTION

5.2.1 Checking of charging voltage

Connect an external voltmeter to the panel voltmeter terminals and check that the output voltage corresponds to the preset value.

Note that if the float charging voltage is temperature regulated, the rectifier must be forced into a state where the temperature regulation stops in order to make the checking possible. In order to achieve this state and by trimming eliminating a possible divergence, see *Users manual*, section *Operation, Trimming of rectifier*.

5.2.2 Checking of measuring instrument

Check that the internal measuring instrument (display) shows a correct value. Follow the instructions stated in the *Users manual*, section *Operation, Calibration of measuring instrument*.

5.2.3 Checking of alarm circuits

Check the circuits that are parts of the alarm system. Follow the instructions stated in the *Users manual*, section *Operation, Test*.

5.2.4 Checking of cooling conditions

Check that the cooling flanges on the back of the rectifier has access to free air flow and that they are not filled with dust or other pollution. Clean if required.

6 FAULT TRACING

6.1 SAFETY INSTRUCTION

WARNING! This product contains dangerous voltage that when touched can cause electrical shock, burn or death.
Service/maintenance work that involves work with removed covering may only be done by authorized service personnel.

WARNING! Overvoltage can cause explosion of electrolytic capacitors and varistors. If work has to be done with power applied, a splinter screen therefore must be used (safety goggles or shielding).

6.2 FAULT TRACING BY AN ALARM

When there is an alarm message, the fault tracing should in first case be based on the information given in the *Users manual*, section *Operation, Alarm messages, Alarm descriptions*. Only after that, or if there are no relevant alarms, you proceed to the instructions in section *Other fault tracing*.

6.3 OTHER FAULT TRACING

The primary fuse is tripping when the rectifier is turned on
Cause 1: Incorrect type of mains fuse. Check that mains fuse follows the specifications in section *Technical data*. Note that delayed-action fuses must be used.
Cause 2: Internal rectifier fault. Call for authorized service personnel.

No rectifier output
Cause 1: The output fuses (battery fuses) has tripped. Check that the output fuse rating is sufficient compared to the rated output current of the rectifier.
Cause 2: The input for external blocking is in open state.
Cause 3: Internal rectifier fault. Call for authorized service personnel.

The rectifier output voltage is too low
Cause 1: High temperature in the battery or battery compartment. Applicable only if the output voltage is temperature regulated. In that case, the rectifier is O.K. Instead, seek the cause of the high temperature. The temperature sensor may also be faulty. Check if the display reports correct battery temperature.
Cause 2: Incorrect setting of float charging voltage level. Change the setting.
Cause 3: Incorrect trimming of output voltage. Make a new trimming of the output voltage.
Cause 4: Internal rectifier fault. Call for authorized service personnel.

The rectifier output voltage is too high
Cause 1: Low temperature in the battery or battery compartment. Applicable only if the output voltage is temperature regulated. In that case, the rectifier is O.K. Instead, seek the cause of the low temperature. The temperature sensor may also be faulty. Check if the display reports correct battery temperature.
Cause 2: Incorrect setting of float charging voltage level. Change the setting.
Cause 3: Incorrect trimming of output voltage. Make a new trimming of the output voltage.
Cause 4: Internal rectifier fault. Call for authorized service personnel.

The rectifier output current is too high
Cause 1: Incorrect setting of current limit. Change the setting.
Cause 2: Internal rectifier fault. Call for authorized service personnel.

The display is turned off but the rest of the rectifier is functioning

Cause 1: The I^2C cable has came loose from the connector X7. Restore the connection. The display backlight now should be turned on but then it may take as long as one hour before the display shows relevant information again. It might happen that the alarm "Internal fault xx01" then is shown. Acknowledge the alarm and it should not come back.

Cause 2: Internal rectifier fault. Call for authorized service personnel.

The pushbuttons doesn't work and/or the display shows rubbish

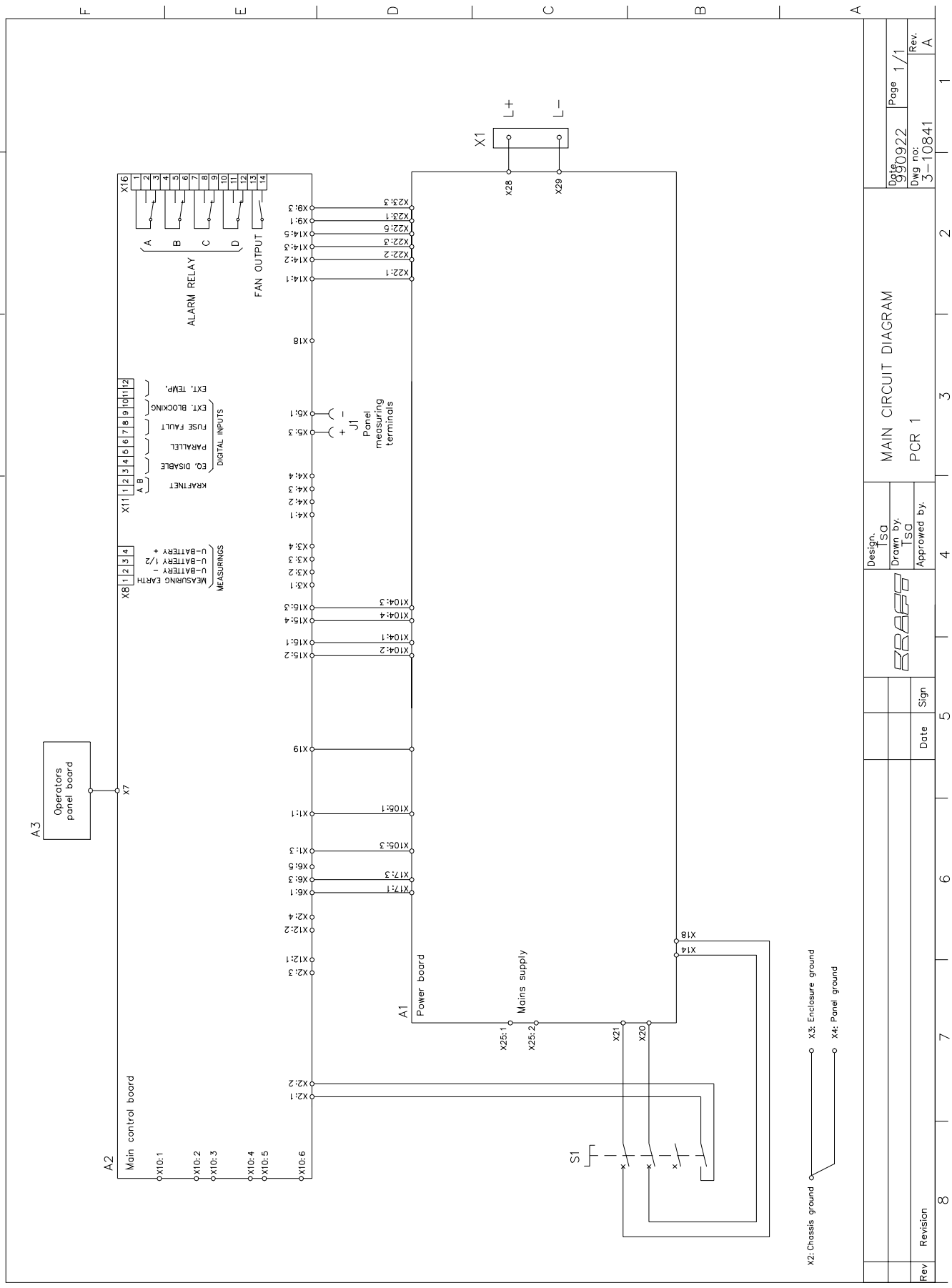
Cause 1: Indicates that the internal microcomputer has locked up. The control electronics has to be restarted by first making it dead. The dead state is achieved by first turning off the rectifier using the mains switch and then disconnect the rectifier from the battery. Let it remain disconnected for a while until the display has completely turned off. Then restart by restoring the battery and then turn on the rectifier mains switch again.

Cause 2: Internal rectifier fault. Call for authorized service personnel.

7 OTHER DOCUMENTS

As appendixes follows on following pages in turn:

- Circuit diagram PCR1
- Additions and changes


MAIN CIRCUIT DIAGRAM
PCR 1
Design: TSO
Drawn by: TSO
Approved by:
Date 990922
Page 1/1
Dwg no: 3-10841
Rev. A
Rev Revision Date Sign
A1 Power board
A2 Main control board
A3 Operators panel board
X1 L+ L-
X16 ALARM RELAY A B C D
FAN OUTPUT
X11 KRAFTNET A B
DIGITAL INPUTS EXT. TEMP. EXT. BLOCKING FUSE FAULT PARALLEL EQ. DISABLE
X8 MEASURING EARTH U-BATTERY - U-BATTERY 1/2 U-BATTERY +
MEASURINGS
J1 Panel measuring terminals
Mains supply
S1
X2: Chassis ground
X3: Enclosure ground
X4: Panel ground

ADDITIONS AND CHANGES